Chapter 6 – An Integrated Pricing Approach

6.1 Carbon Pricing

On both federal and regional (interstate) levels, various carbon pricing schemes have been discussed, all of them variants of either a carbon tax or a cap-and-trade system. Most carbon tax proposals apply a fee for every ton of carbon delivered in fossil fuels, sacrificing control over the total emissions for the benefit of price certainty to the market. Cap-and-trade systems control the total emissions by allocating a fixed number of allowances to emitters and allowing them to trade those allowances at whatever prices develop in the market. Cap-and-trade systems sacrifice price certainty for the benefit of precise control of the emissions.

Neither Commerce nor the Advisory Committee was able to conclusively identify a preferred method of carbon pricing. However, in order to scale the impact of any carbon pricing option on the state energy system, Commerce chose to quantify costs and impacts of a revenue-neutral carbon tax option, following British Columbia's policy design.

6.2 Analysis of a Revenue-Neutral Carbon Tax Option

6.2.1 Introduction

A revenue-neutral carbon tax applies to all fossil fuels consumed in the state, both direct fuel consumption, such as building heat and motorized transportation, and electrical generation. British Columbia (BC) introduced the first revenue-neutral carbon tax in the region in 2008, aimed at reducing fossil fuel consumption by sending price signals to consumers to incentivize more efficient fuel use. Its primary advantages are to provide: 1) price certainty for consumers and businesses so that they can make efficient energy investment and purchasing decisions;[241] 2) completeness as an economy-wide policy program that targets fuel consumption in all sectors and consumers; and 3) welfare improvement by reducing dead weight loss, which is an economic term describing inefficiency caused by overconsumption of products where the cost of associated pollution is not incorporated into the products retail price.[242] Although a carbon tax does result in higher energy prices, consumers and businesses need not be adversely affected if the revenues from a carbon tax are used to offset other state taxes. A carbon tax can potentially impose greater burden to low-income households and small businesses as the share of energy-related expenditures for these subgroups is generally higher. However, it is possible to mitigate this effect by providing various mechanisms in the revenue recycling package, such as an additional low-income tax credit, such as is used in the BC carbon tax program.[243] When

[241] Ian W.H. Parry and William A. Pizer, "Emissions Trading Versus CO2 Taxes Versus Standards," *Assessing U.S. Climate Policy Options*, Resources for the Future, November 2007: pp. 81-82, www.rff.org/rff/Publications/upload/31809_1.pdf **(R0153)**

[242] Lawrence H Goulder, *Environmental Taxation and the "Double Dividend:" A Reader's Guide*, NBER Working Paper No. 4896, National Bureau of Economic Research, 1994. **(R0154)**

[243] British Columbia Ministry of Environment, *BC Climate Action Plan*, 2008, www.livesmartbc.ca/attachments/climateaction_plan_web.pdf: pp. 16. **(R0155)**

designed carefully, this revenue neutrality can therefore maintain or improve economic competitiveness and improve social welfare by reducing fuel consumption and pollution.

Specific parameters and design elements for a carbon tax are subject to further discussion, but for this modeling exercise the 2012 Energy Strategy generally assumes that Washington will model its carbon tax after BC's in the following ways. A carbon tax will be collected in the same manner as existing fuel taxes. It does not apply to marine and aviation fuels for interstate and international trips to prevent leakage effects, which is a diversion of refueling events (fuel consumption) caused by geographic price differentials, and imported electricity will be exempted from this taxation to avoid potential legal issues. Matching the BC carbon tax policy, the baseline rate would start at $10 per metric ton of carbon dioxide equivalent ($MTCO_2e$) with an incremental rate at $5/$MTCO_2e$ per year, with the tax rate eventually capped at $30/$MTCO_2e$. This cap rate roughly equates to a price increase of 30 cents per gallon for regular motor gasoline. Carbon tax revenues are assumed to be returned to the taxpayers primarily in the form of rate cuts for existing state taxes.

6.2.2 Previous Research

Carbon Tax Center, a national nonprofit advocacy group, developed an elasticity-based spreadsheet model to estimate the impacts of a national carbon tax.[244] This model demonstrates the potential impacts of a tax, but does not account for complex energy-related dynamics such as its effect on fuel mix for electric generation. In contrast to this elasticity-based approach, upon introducing the first economy-wide carbon tax, BC used a general equilibrium model called the CIMS to estimate the societal impacts of the carbon tax.[245] The primary advantage of general equilibrium models is that they can account for substitution effects and predict economy-wide impacts along with fiscal and environmental impacts. This feature was demonstrated in several research papers, such as *Analysis of Policies to Reduce Oil Consumption and Greenhouse-Gas Emissions from the US Transportation Sector*,[246] which used a U.S. general equilibrium energy model called the NEMS to predict its impacts on the transportation sector. This approach, however, requires substantial financial resources and staff time to complete due to the complexity of general equilibrium models.

For economic analysis, the results from Washington Western Climate Initiate Economic Impact Analysis,[247] provides a useful estimate of potential economic impacts for Washington. This study used an energy equilibrium model called Energy 2020 to analyze the economic impacts of regional cap-and-trade. The study concluded that the effects on employment and total output could vary from one sector to another but are likely to be net positive when implemented with

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[244] "Effectiveness," Carbon Tax Center, www.carbontax.org/issues/energy-demand-how-sensitive-to-price/, (accessed on May 11, 2010). **(R0156)**

[245] BC Ministry of Environment, *BC Climate Action Plan, Appendix I: A Quantitative Analysis of British Columbia's Climate Action Plan*, 2008, www.env.gov.bc.ca/cas/pdfs/climate_action_21st_century.pdf **(R0157)**

[246] Ross W. Morrow, Kelly Sims Gallagher, Gustavo Collantes, and Henry Lee, "Analysis of policies to reduce oil consumption and greenhouse -gas emissions from the US transportation sector," *Energy Policy* 38 (2010): 1305–1320, doi:10.1016/j.enpol.2009.11.006 **(R0158)**

[247] ECONorthwest, *Washington Western Climate Initiate Economic Impact Analysis*, Feb 15, 2010 www.ecy.wa.gov/climatechange/docs/20100707_wci_econanalysis.pdf **(S0024)**

other efficiency measures. Another study by Morgenstern *et al* found that using the past data and general equilibrium model, the effects on manufacturing is negligible except for a few energy intensive industries, and the impacts on these industries can be minimized with mitigation measures such as a border tax and revenue offset for the U.S. as a whole.[248]

6.2.3 New Analysis

Commerce developed an elasticity-based spreadsheet model called the Carbon Tax Analysis Model (C-TAM). This model is an open-source model based on three major elements: 1) carbon tax rates, 2) the EIA's energy price and demand forecasts,[249] and 3) price elasticities of demand (indicators of how consumer demand responds to price changes). Due to its dependency on the EIA forecast, C-TAM predicts the impacts on a production basis, meaning that the fuel used in another state to generate electricity consumed in Washington is not included in the forecast. C-TAM is designed to account for the effects of complex price changes for each fuel type and likely fuel mix change for electric generation. The elasticity selection is based on a thorough literature review covering a wide array of fuel products, ranging from transportation fuels to sector-by-sector electricity consumption. The analysis results are disaggregated for each fuel source and sector (residential, commercial, industrial and transportation).

The primary advantage of C-TAM over more sophisticated models such as the NEMS is to provide policy makers the ability to better understand the model and to change various assumptions and parameters to explore the impacts of various carbon tax designs. Furthermore, C-TAM is far less resource intensive, yet produces detailed projections for each sector and fuel source, and accounts for the complex interaction of energy price and demand.

The model forecasts that with the baseline parameters described earlier, a carbon tax can reduce energy-related emissions by 8.4 percent from the projected level in 2035, with $2.1 billion of carbon tax revenues for the same year. The impacts on fossil fuel consumption are highest for the electricity sector, with far smaller impacts on transportation fuel consumption. A carbon tax has a greater impact on electrical generation because of the high carbon intensity of coal-fired electric generation.

Further analysis was pursued to examine the impacts of using alternative cap rates. Figure 6-1 summarizes the results of this sensitivity analysis, and it suggests that a carbon tax of $70 per MTCO$_2$e is sufficient to stablize the energy-related emissions at 1990 levels in 2035. In addition, a carbon tax at $90 per MTCO$_2$e would be able to retire all electricity generating plants using fossil fuel. In reality some of these plants would need to be preserved as backup power for certain conditions, such as low water years and very cold days.

[248] Richard D. Morgenstern, Joseph E. Aldy, Evan M. Herrnstadt, Mun Ho, and William A. Pizer, "Competitiveness Impacts of Carbon Dioxide Pricing Policies on Manufacturing, " *Assessing U.S. Climate Policy Options*, Resources for the Future, November 2007: 96-105, www.rff.org/rff/Publications/upload/31811_1.pdf **(R0159)**

[249] Energy Information Administration, *Annual Energy Outlook 2011*, Mar 2011, www.eia.gov/forecasts/aeo/ **(R0090)**

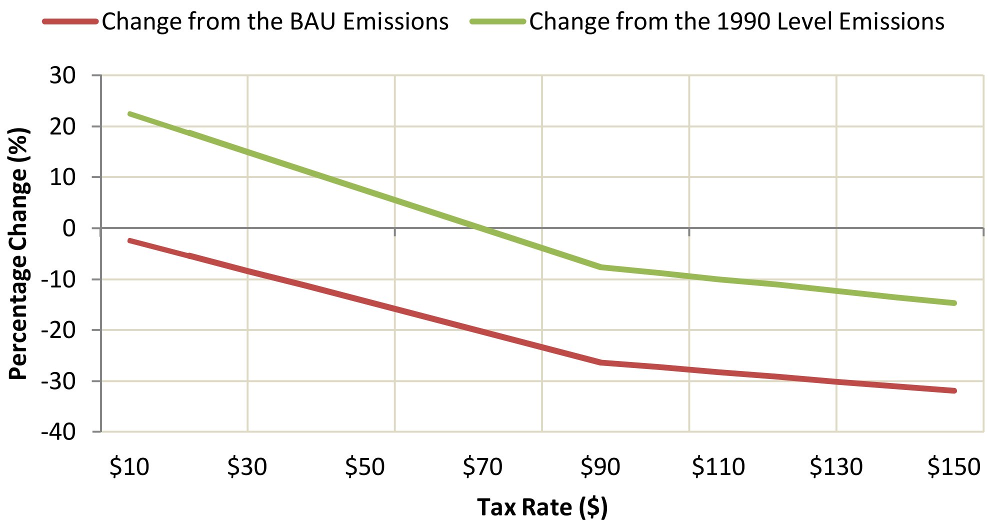

Figure 6-1: Emission Changes in 2035 with Various Rates

6.3 A Test for Scenario Planning

One of the objectives of the 2012 Energy Strategy was to model the effectiveness of different energy policy options under different scenarios. The prime variables used to differentiate the different scenarios were energy price and technology. The effectiveness of the carbon tax policy was examined under a reference scenario and four other scenarios that approximate the four future worlds described in Section 2.2. These four scenarios were selected from scenarios published in the EIA's Annual Energy Outlook 2011 and are *high oil price*, *low oil price*, *high technology* and *low technology*. The carbon tax model was run under the five scenarios (including the reference case), each time modeling a five-year phase-in of a $30 carbon tax, starting with $10 in 2012.

Reference: This scenario is derived from the EIA's reference scenario. The price for imported low sulfur oil rises to $125 per barrel in 2035 (constant 2009 dollars). Other energy prices also slowly rise in this scenario.

High oil price: This scenario is derived from the EIA's *high oil price* scenario. The price for imported low sulfur oil rises to $200 per barrel in 2035 (constant 2009 dollars). Other fuel prices are impacted as well, but to a much smaller degree. A reference level of technology is in place in the high oil price scenario.

Low oil price: This scenario is derived from the EIA's *low oil price* scenario. The price for imported low sulfur oil declines to $50 per barrel in 2035 (constant 2009 dollars).

High technology: In the *high technology* scenario, consumers have more options to shift away from various fuels as their price increases. The increase in energy prices follows the reference scenario forecast. To reflect a more innovative high technology world, the price elasticity values in the carbon tax model were increased by 20 percent, which corresponds to one standard deviation.

Low technology: To reflect a less innovative more stagnant low technology world, the price elasticity values in the carbon tax model were decreased by 20 percent, which corresponds to one standard deviation.

Table 6-1 illustrates the forecast 2020 and 2035 greenhouse emissions for the five scenarios following the imposition of a $30 carbon tax. The high and low technology scenarios have only minor impacts on greenhouse gas emissions. The oil price scenarios have much larger impacts on greenhouse gas emissions, with emissions down nearly 20 percent in 2035 in the high oil price case.

Scenario	2010	2020	2035	change 2020	change 2035
	MCO_2e	*MCO_2e*	*MCO_2e*	*%*	*%*
Reference	71.4	72.67	76.58	--	--
Reference: w/ tax	--	69.66	70.26	-4.1%	-8.3%
High Technology	--	69.23	69.71	-4.7%	-9.0%
Low Technology	--	70.55	70.82	-2.9%	-7.5%
High Oil Price	--	67.54	61.50	-7.1%	-19.7%
Low Oil Price	--	75.37	78.56	3.7%	2.6%

Table 6-1: Effect of a $30/MgCO$_2$e carbon tax on energy greenhouse gas emissions under multiple future scenarios. (W0007, W0011)

Table 6-2 illustrates the forecast 2020 and 2035 energy consumption for the five scenarios following the imposition of a $30 carbon tax. The results show a similar trend between scenarios as noted above. Under the low oil price scenario, energy consumption increases significantly.

Scenario	2010	2020	2035	% change 2020	% change 2035
	MCO_2e	*MCO_2e*	*MCO_2e*	*%*	*%*
Reference: no tax	1.389	1.578	1.727	--	--
Reference: w/ tax	--	1.543	1.680	-2.2%	-2.7%
High Technology	--	1.537	1.672	-2.6%	-3.2%
Low Technology	--	1.549	1.689	-1.8%	-2.2%
High Oil Price	--	1.443	1.552	-8.6%	-10.1%
Low Oil Price	--	1.629	1.803	3.2%	4.4%

Table 6-2: Effect of a $30/MgCO$_2$e carbon tax on Washington energy consumption under multiple future scenarios. (W0007, W0011)

6.4 Next Steps

- Apply Washington economic I/O model, or Washington REMI model, to refine modeling of economic impacts from various implementations of a revenue-recycling carbon tax.
- Energy Office to begin biannual reporting, in January of odd-numbered years, on status of carbon pricing policies worldwide and contemporary research on their economic impacts.

Focus on those political entities most relevant to Washington, e.g. British Columbia and California.

- Establish an annual forum on research in carbon pricing at the Washington Future Energy Conference, focusing on invitations to academic researchers both inside and outside Washington.